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GOVERNMENT OF BOMBAY.

REPORT OF THE POWER RESOURCES SURVEY COMMITTEE.

1. TERMS OF REFERENCE - Under Government Resolution, Public Works Department, No. 2272/36, dated the 27th July 1938, Government were pleased to direct that the Electrical Engineer to Government and the Director of Industries should jointly make a survey of the entire power resources of the Province of Bombay, with special reference to the possibility of establishing large centralised thermal and hydro power stations to generate electricity at low and economic rates and by means of a grid system inter-linking the various generating stations in the Province of Bombay to make electrical energy available both in urban and rural areas at cheap rates for lighting, power and agricultural purposes.

2. SPECIAL OFFICER - After the issue of the above Resolution, Government appointed a Special Officer, Dr. B.K. Ram Prasad, M.A., D.Sc., to assist in the investigation of the hydro-electric projects in the Province. Dr. Ram Prasad carried out the work originally sanctioned by Government to Mr. N. B. Gadre.

3. THE MOST ECONOMIC METHOD OF POWER UTILIZATION - The most economic method for utilising hydro-electric power is when the load is situated reasonably near the source of supply. In the Bombay Province, this ideal situation only occurs in the central portion of the Province, and has been taken full advantage of by Messrs. Tatas, who have erected hydro-electric generating stations at Bhira, Khopoli and Bhivpuri with a total Plant capacity of 183,500 K.W., which is being increased to 187,000 K.W., and is utilised within 100 miles of the generating stations. There is a large industrial load in the Northern portion of the Province, i.e. Gujerat, but there is no economic source of hydro-electric power nearby. In the Southern portion of the Province from Belgaum down to the borders of the Mysore State, there is a number of potential sources of hydro-electric power, aggregating may

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many thousands of horse power, but at present there is no means of ~~k~~ utilising this power without transmitting the same very considerable distances, which would make the cost of the power prohibitive.

4. GRID SYSTEM - At present electricity is available only in cities and towns. The ideal state would be that electricity should be available in most of the urban and rural areas of the Provinces at low rates. In rodern to achieve this without undue expenditure, some of the existing stations under private Controal can be developed, new thermal and hydro stations erected, the inefficient stations closed down, and transmission lines interconnecting the existing efficient stations and new stations erected, thus making available wholesale power ~~fxm~~ power licensees in urnan areas for distribution in their areas, and cheap power for rural areas. To bring this about, it will be necessary to organise the supply and ~~in~~ distribution of electircity in the ~~Kar~~Province on a grid system and unify its contral in the hands of a central authority. This authority should be a statutory body, and the sole purveryor of wholesale electricity, selling it for distribution to existing and future licensees. Where - specially inrural areas - there are no suitable parties available to be granted distribution licensees, the central authority may distribute the energy to the consumers direct; we have referrred to this a matter of central authority in detail in a later paragraph. So far as the grid system is concerned, we have divided the Province into nine zones, each zone having a radius of 50 miles. A reference is invited to the attached map of the Province showing the zones. Within each zone, there is a main source of ~~k~~ electric supply, with subsidiary sources, which may ~~kentitlent~~ be ~~kkkk~~ utilised as and when necessary. The transmission lines interconnecting the various stations within each zone are proposed to be .....

are proposed to be so arranged that the main sources of supply will be connected up with the existing distribution centres in order to provide a bulk supply at at a cheaper rater than can at present be obtained with small diesel engine driven generating sets. As all the zones are interconnected, each zone may be fed from the neighbouring zones. Wherever water is available, hydro-electirc stations have been provided for; where it is not possible to have hydro-electric stations, thermal stations have been allowed for. The following are the zones into which the Province has been divided, with particulars of the main sources of supply for each zone. (On the attached map, the thermal zones have been indicated by yellow boundary lines and the hyro-electic zones by green boundary lines):

I.	Ahmedabad	...	Thermal.
II.	Surat.	...	Thermal.
III.	East Khandesh	...	Thermal.
IV.	Bombay. West Khandesh	...	Hydro.
V.	Bombay,	...	Hydro.
VI.	Deccan,	...	Hydro.
VII.	Sholapur	...	Thermal.
VIII.	Gokak.		Hydro.
IX.	The extreme Southern Portion of the Province.	...	Hydro.

5. DIVISION OF THE PROVINCE IN ZONES - In some of the zones efficient electric generating stations are already existing. The Companies operating these stations have been approached with a view to the proposed central authority purchasing power from them for resale in bulk, which procedure the Companies are agreeable to on suitable terms. In most cases it will be necessary for the Companies in question to increase the capacity of the existing plant in order to provide the extra output required.

..... Zone No. I..

Zone No. I - Ahmedabad: The Ahmedabad Electricity Co. Ltd. are operating a thermal station, generating electricity by means of steam-turbines totalling 22,500 K.W. capacity. This station is adequate for the load demands for some time to come and can be increased in capacity as and when necessary.

Zone No. II - Surat: The Surat Electricity Co., Ltd. are generating electricity by means of diesel engines aggregating 3,624 K.W. capacity and the further requirements of the same can be provided for by means of additional plant.

Zone No. III - East Khandesh: New thermal stations of 3,000 K.W. capacity each have been allowed for at Jalgaon and Chalisgaon. These can be increased in capacity when necessary.

Zone No. IV - West Khandesh: At present there is a very small load in this zone which can be taken care of by suitable hydro stations at the Wilson Dam and Radha Falls. Provision for the first stage of development of the generating sets amounting to 2,000 K.W. has been allowed for in this project.

Zone No. V - Bombay: This zone is already provided for by Messrs. Tata Hydro-Electric Agencies, Ltd. Additional requirements can be met by the development of the Koyna Hydro-Electric Project, as also there are hydro-electric possiblities in the Arr and Mulla Rivers. No provision has been made in our proposals for any further development in this zone except for interlinking the transmission lines.

Zone No. VI - Deccan: As there is a very small demand for power in this zone, it can be amply provided for by the Hydro-Electirc Project at the Bhatgar Dam. The existing plant has an output of 1,000 K.W. and extensions upto 8,000 K.W. can be added.

Zone VII - Sholapur: The main loads are in the neighbourhood of Sholapur and Barsi. In Sholapur ..... already exists .....

already exists a thermal station belonging to yhe Sholapur Spinning and Weaving Co., Ltd., which can be suitably extended as and when necessary by the Company concerned.

Zone No. VIII - Gokak: Electricity is being generated at Gokak by the Gokak Mills, Ltd., and with the provision of a Dam on the Malaprabha River, it is possible to generate sufficient power to feed not only this zone, but also to help out nearby requirements in the Southern Portion of the Province, Zone No. IX. No provision for the cost of the Dam has been made in our project, as it is understood that the Dam is primarily required for irrigation purposes and the cost of the necessary water required for hydro-electric purposes would be met from the charges for the current supplied.

Zone No. IX - The extreme Southern Portion of the Province: This zone contains projects which can be developed to the extent of several thousand horse power, but the load requirements are at present very small. Power could be taken from the Mysore State at Gersoppa, until the industries in the zone are further developed, and then the Kalinadi River Project, capable of providing upto 48,000 K.W., could be taken in hand. For the present, provision has been made in our costs for a transmission line from the Gersoppa Falls to feed this zone.

6. APPENDICES GIVING DETAILS OF COSTS, ETC. - As pointed out previously, all the zones will be interconnected. Under this arrangement, the various stations will help each other, when necessary. Appendices I to VII give detailed information in connection with the zones, transmission lines, transformer centres, etc. as under:

APPENDIX I - Transmission Lines:

(a) the towns which will be linked up with the main generating stations in each zone;

(b) the length of the transmission lines;

(c) the voltage of the transmission lines;

(d) the cost per mile, including the necessary

(d) the cost per mile, including the necessary telephone line for communication purposes;

(e) the total cost of each main bulk line;

(f) the total cost of the transmission lines in each zone;

APPENDIX II - TRANSFORMER CENTRES:

(a) towns in each zone to which it is proposed to give a bulk supply;

(b) the voltage of the transmission lines;

(c) the capacity of the transformers which will be provided in order that the existng distributing licensees may be provided with a voltage the same as their present generating voltage;

(d) the cost of the transformers;

(e) the cost of the swithhgear necessary for operating the transformers;

(f) the cost of providing buildings for housing the transformers and swithhgear; (in a number of towns the transformers and switchgear will be housed in the present power stations, thus obviating the cost of additional buildings);

(g) the total cost of the transformers, swithhgear and buildings in each town;

(h) the total cost for each zone.

APPENDIX III - Summarised Statment giving:

(1) zone numbers;

(2) location of the generating station in each zone, as also a note whether the station is existing or not;

(3) the type of generating station, i.e. thermal or hydro;

(4) the present or proposed capacity of the station.

(5) the cost of the generating station;

(6) particulars as to whether the cost of the station is actual cost already spent on the

ON the same, or where the station is not existing, the the estimated cost;

(7) the cost of the transmission lines in each zone, as per Appendix I;

(8) the cost of the receiving and distributing stations in each zone, as per Appendix II;

(9) the total amount required to be expended in each zone.

APPENDIX IV - This appendix shows the towns in which electricity is at present being generated by thermal stations or purchased in bulk from Hydro-Electric Companies and distributed locally by the various licensees in all the zones. It also contains the names of a few towns (marked with an*) in which no electricity is at present available and to which under the proposed grid system electricity will be made available. The existing inefficient stations in all the zones are proposed to be shut down under out scheme, and bulk supply will be made available by the central authority to such licensees for distribution. These stations will, however, not be dismantled, but kept as a standby for operation in emergencies.

APPENDIX V - gives a list of towns in which electric supply is now available under the licenses granted to these towns which cannot be included in the proposed grid scheme because of the uneconomical nature of the transmission lines owing to their lengths. These towns will continue to be supplies by the local licensees until such time as sufficient development takes place to absorb them in the grid scheme.

APPENDIX VI - gives a list of towns for which applications for electric licenses have been received, but which cannot be included in the grid scheme owing to the uneconomical nature of the transmission lines. When the grid scheme has been further developed, it is

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it is hoped that all the towns given in Appendixes V and VI will be served by means of the grid system.

APPENDIX VII - gives a statement of towns to be included in the grid system, rate at which electricity in bylk is porposed to be supplies, revenue and expenditure of the proposed Central Electricity Board, etc.

7. CAPITAL COST - From Appendix III it will be noted that the total capital cost of the scheme is estimated at Rs. 21.5 lakhs for new generating stations; Rs. 200,2 lakhs for transmission lines, and Rs. 14.2 lakhs for transformer stations. To this must ne added some Rs. 20 lakhs for distribution in rural areas not undertaken by licensees, and miscellaneous capital expenditure, making a totsl of Rs. 256 lakhs.

8. EXPENDITURE & REVENUE - The information given in Appendices I, II and III has been summarised in Appendix VII. In this Appendix, information has been given in regard to the cost of the transmission of electrical energy per unit on the basis of the estimated demand one year after the commencement of the undertaking of the grid scheme. It will be seen from Appendix VII that the total number of units sold about one yyear after commencement of the grid scheme in all the zones, excluding the towns which will be uneconomical to include in the grid scheme at present, amounts to 680 million units per annum. Six hyears after the commencement, this figure is expected to increase to about .714 million units. As has been stated previously, the central authority must be the sole purveryour of electricity in the Province; it must pruchase electricity at wholesale rates from the selected stations and generate its own where the absence of economic generating staions warrant the same. In the former case, owing to extendions brought about by the activities of the central authority, the costs of generation will be reduced. The difference between the present cost of generating and the nw new lower cost of generation must accrue to the ....

to the central authority to enable it to meet part of its annual expenditure. It is reasonable to assume that the central authority will require to expend annually a sum equal to 10 per cent of the capital costs of the grid system on maintenance, depeciation and interest charges. In Appendix VII will be found the rates at which the central authority should be able to sell electiricity wholesale; the rates shown are slightly lower than the rates at which the existing stations are able to generate electricity. The same appendix also shows the total revenue of the central authority from the sale of wholesale electricity in the second and sixth years of operation. It also shows the annual expenditure of the authority on account of maintenance, depreciation and interest charges as well as cost of purchase or generation of electricity. In the second year of operation, it will be noted that the total revenue is estimated at Rs. 18.5 lakhs and expenditure at Rs. 33.6 lakhs showing a loss of about Rs. 15 lakhs. In the sixth year of the scheme, the figures will be Rs. 42.7 lakhs and Rs. 39.7 lakhs respectively showing a profit of about Rs. 3 lakhs. To the loss of Rs. 15 lakhs in the second year shoudl be added a further sum of Rs. 2 lakhs for administration charges. It is thus acticipated that a loss of some Rs. 17 lakhs must be faced which will be gradually reduced until in the sixth year of the scheme it is likely to be self-supporting. This loss should, we think, be met by the industry itself. As mentioned previously, there would be sold in the Province in the second year of the scheme about 660 million units, increasing to 714 millions in the sixth year of the scheme. We propose that from the operation of the scheme, all the licensees who generate and distribute electircity should pay to the central authority one rupee per every block of 400 units sold, or about half a pie per unit. This will bring in about Rs. 17 lakhs per year. As the loss gradually decreases with the develop

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development of the project, this special sales tax could be reduced until it becomes either negligible or is entirely wiped out. Under the arrangement proposed by us, Government will not be called upon to meet any expenditure on account of the central authority. This body will raise its own money in the form of Debentures for capital expenditure under Government guarantee of say 3½ per cent interest, and will meet in the first few years its losses from a special sales tax on all electricity sold.

9. CONTROL- To carry out the grid scheme as detailed prevously, it is essential that the control be unified and placed in the hands of central authority called "The Central Electricity Board" which should be statutory body with a Chairman and about six Members. It is essential that the Chairman of the Board should be an Electrical Engineer with busindss and industrial experience. At least three Members should be experienced Electrical Engineers, one member with accounts experience, one financier and one industrialist. The Board should be authorised to raise debentures to the extent of rupees three crores in the first instance under a Government guarantee of interest equalling 3½ per cent. It is expected that within a reasonably short time, the Board's entire expenditure, influding interest payble on the debentures, would be met from its income; until this transpires, the deficit should be met ; as suggested in the previous paragraph by a special contribution raised from each of the existing and new licensees in proportion to the total sale of units per year by each licensee.

The Central Electricity Board should be the sole purveyor of electircity in bulk. In order that the provisions of the Indian Electricity Act may be complied with in as far as the existing licensees are

are concerned., it is not intended that the Board should purchase the existing electrical under takings, but should enter into a working arrangement with certain of the efficient existing licensees, so as to purchase the entire electricity generated by them, and to distribute it in bulk. For this purpose, the Central Electricity Board will examine the working of the various electircal generating staions at present in the Province and select those efficient stations which fall into the scheme drawn up by us. These stations should be called "The Selected Staions". The Board will buy from these selected stations the centire output of their electricity on fixed terms to be prescribed under the rules framed under the special Act which it will be necessary to pass in this connection. The Board in addition to purchasing the entire output of electircity of the existing selected stations, will generate, where necessary, energy in its own thermal and hydro-electric stations, and for this purpose, it will put down stations at its own cost. The Board will also erect the necessary overhead transmission lines interconnecting the various existing generating stations in the Province. The Board will sell electricity in bulk to the existing licensees for distribution in their areas, and will also arrange to sell electricity in bulk to all new undertakings which may agree to distribute and retail electricity in areas at present not served by any licensees. The Board may also distribute energy direct in the rural areas, as and when necessary.

10. SUMMARY OF PROPOSALS AND RECOMMENDATIONS -

We propose that in order to make cheap electricity available in both urban and rural areas, a grid system should be adopted, existing efficient power stations extended, inefficient stations shut down, new hydro and thermal stations established and transmission lines

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transmission lines traversing the Province erected, interconnecting the various generating stations. We further propose that that the control of electric supply in bulk should be centralised in the hands of a statutory body called the "Central Electricity Board", which should be the sole purveyor of electricity in bulk in the Province. A special Act would require to be passed, creating this Board and giving it specific powers such as raising the necessary debenture capital under a Government guagantee of 3½ per cent interest, putting down generating stations, transmission lines, etc., having the monopoly of the sale in bulk of electricity in the Province, levying a special sales tax on all electricity sold by distributors to meet its annual deficity it any, purchasing electricity from recognised selected stations at rates laid down in the rules under the proposed special Act, and so forth.

Until Government are pleased to issue orders on this report, it is recommended that no licenses for the supply of electricity in bulk may be granted.

The figures of costs given by us are at the rates prevalent in August 1939. As a result of the War, an increase in prices of equipment has taken place. We have not attempted to revise out figures, in view of the fact that when the orders of Government are issued, the special Act referred to above duly passed by the Legislature and the Central Board set up, some time will have elapsed so that in any case it will be essential for the Board's experts to invite tenders and to bring all the figures upto date. This, in our opinion, is not likely to affect the scheme proposed by us seriously. We would accordingly recommend strongly that Government will be pleased to take the necessary steps at an early date to give effect to our recommendations.

We have shown in paragraph 8 that the Provincial

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We have shown in paragraph 8 that the Provincial revenues will not be called upon to meet any expenditure in connection with out proposals. We would nevertheless stress the fact that the scheme proposed by us should not be veiwed from the financial aspect of profit and loss alone. There must in the consideration of this scheme be taken into account the great benefit which will accrue to the Province, as by making electric power available at a low rate all over the Province industries in general and agriculature will benefit greatly. Just as railways have opened out and increased the productive power of the areas they have passed throuth, similar benefit will accrue by the transmission and distribution lines which are proposed to be put up to make electricity available all over the Povince. The "Grid" system in England has done a great deal for the British industry and agriculture, and there is no reason why it should not do the same in this Province.

The following taken from page 520 of the British journal "The Economist" of March 23, 1940, in connection with the British Grid System will be read with interest:

> "One of Britain's most enduring economic achievements in the twenty-one years between the Great War and the Hitlwer war was her electrification. The "Grid" constructed opportunely during the depression of the early 'thirties, was on e of the most decisive achievements in our industrial evolution since the Railway Age. But before the first pylon was erected electrification was proceeding apace. The properation of facteries subject to the electricity regulations had risen from 49.0 per cent. of the total in 1921 to 58 cent, in 1924, 72.0 per cent. in 1929 ar 72.6 per cent. in 1930. By 1935, when the was complete, the preperation was 83.9 and to-day it is even higher". ...

83.9 per cent., and to-day it is even higher".

Sd/-

Electrical Engineer to Govt.

Sd/-

Director of Industries.

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